

## **REMARKS**

Reconsideration of this application is respectfully requested. Claims 1-4 and 6-11 are currently pending. Claim 5 is cancelled and its features incorporated into claim 1. Claims 1 and 6 are currently amended. No new matter has been added.

### **A. The Rejections Under 35 U.S.C. § 103 Should be Withdrawn**

Claims 1-11 stand rejected under 35 U.S.C. § 103(a) as allegedly being obvious over JP 2002-134122 "Otomo" in view of U.S. 6136469 ("Li"). Specifically, the Office Action alleges that although Otomo is silent towards the heteropolyacid catalyst being a "partial salt" with an alkali metal, Li teaches a heteropolyacid with crystals having defects in the structure (partial salt) having a metal ion including ammonium, a group 1A element (sodium, potassium) and group 2A element (alkali earth metal) because these defects result in better ion conduction pathways. *See*, Office action at pages 3-4. The Office Action concludes that it would have been obvious for the solid heteropolyacid of Otomo to have a defect structure (partial salt) in the fuel cell material because Li teaches the partial salt of a heteropolyacid solid crystals results in better ion conduction pathways. *See*, Office action at page 4. The Office Action further alleges that claims 2-11 are each obvious over Otomo in view of Li for the reasons cited in the Office Action at pages 4-5. In light of the amendments to independent claim 1, Applicants respectfully traverse the rejections for at least the following reasons.

#### **1. The Combination of Otomo and Li Fails To Teach or Suggest All of the Elements of Claims 1-11.**

Applicants respectfully submit that even if there was suggestion or motivation to combine Otomo and Li – which as discussed below there is not – the combination does not teach all elements of the invention of amended claim 1, *inter alia*, those relating to the novel solid heteropolyacid catalyst for a fuel cell. With respect to independent claim 1, as amended, Applicants respectfully submit that Otomo does not disclose several elements. First, as acknowledged by the Office Action, Otomo fails to teach a "partial salt" of a heteropolyacid with

an alkali metal selected from the group consisting of sodium, potassium, and combinations thereof. *See* Office Action at page 4 lines 1-2.

More particularly, contrary to the assertion in the Office Action, Otomo does not disclose that a defective vacancy is formed in a heteropolyacid and a noble metal atom is inserted (substituted) in a skeleton of the heteropolyacid as recited in claim 1. Claim 1 has been amended by incorporating the features of cancelled claim 5, and, therefore, Applicants will address the features in this claim here with respect to amended claim 1. Regarding claim 5, the Office Action alleges that Otomo teaches a heteropolyacid where one of the noble metal (platinum or palladium substituted for hydrogen) is substituted in a skeleton of the heteropolyacid. *See*, Office Action at page 4. However, upon analyzing Otomo, Applicants submit that Otomo fails to teach inserting or substituting a noble metal atom and/or a transition metal atom such as platinum into the skeleton (architecture) the heteropolyacid. In contrast to amended claim 1, Otomo teaches a normal heteropolyacid comprising hydrogen, oxygen, phosphorous, a first metal, and a second metal with a molecular formula, such as  $H_3PW_{12}O_{40}$ . *See*, abstract and paragraphs [0024], [0031], and [0035]. Otomo specifically teaches that some of the hydrogen (H) atoms of the  $H_3PW_{12}O_{40}$  heteropolyacid structure can be replaced by a third element, which can be platinum, ruthenium, nickel, copper, iron, palladium, cobalt, and cesium. *See*, Otomo paragraphs [0012] and [0035]. In other words, Otomo teaches replacing part of the hydrogen atoms in the skelton of the heteropolyacid with a third element such as platinum, but Otomo does not teach that at least one atom of the noble metal and/or transition metal is substituted in a skeleton of the heteropolyacid as recited in amended claim 1.

Indeed, the distinction in the heteropolyacid of claim 1 from that of Otomo becomes apparent by reviewing the synthesis of the heteropolyacid of the claimed invention, which illustrates how the noble metal atom is inserted (substituted) into the architecture of the heteropolyacid. For example, the specification in Example 2, describes a method of synthesizing a heteropolyacid with the structure  $K_4H_2[\alpha-SiPtW_{11}O_{40}]$  wherein Pt has been inserted into the “defective vacancy”. *See*, page 19, l.16 through page 23, l. 23. Applicants submit that the recitation, “at least one atom of the noble metal and/or a transition metal is substituted in a

skeleton of the heteropolyacid" in amended claim 1 involves insertion into the "defective vacancy" sites of the skeleton of the heteropolyacid. *See*, specification at page 8 ll. 1-7. The synthesis process involves preparing a precursor, such as,  $K_8[\alpha\text{-SiW}_{11}\text{O}_{39}]$ , which contains the "defective vacancy sites" and then reacting this precursor with  $\text{H}_2\text{PtCl}_6$  overnight, filtering, and purifying the final product to yield  $\text{K}_4\text{H}_2[\alpha\text{-SiPtW}_{11}\text{O}_{40}]$ , wherein the Pt atom is inserted/substituted into the defective sites. Further, characterization using cyclic voltammetry, IR and X-ray powder diffraction show that the platinum atom has been substituted into the "defective vacancy" sites of the Keggin structure. *See* pages 22-23.

In contrast, Otomo does not teach a synthesis method for inserting a metal (such as platinum) into the heteropolyacid architecture at the "defective vacancy" site. Otomo never teaches synthesizing a precursor heteropolyacid compound containing "defective vacancy" sites. Instead, Otomo teaches replacing the hydrogen by a third element in the heteropolyacid ( $\text{H}_3\text{PW}_{12}\text{O}_{40}$ ), which to a person skilled in the art literally means substituting the hydrogen atoms with a metal in the heteropolyacid architecture but not substituting a metal into the "defective vacancy" site in the architecture. Otomo's concept is similar to replacing the hydrogen with a metal ion such as the elements of group 1A and 2A in a stoichiometric fashion, such as  $\text{H}_3\text{xE}_{3\text{x}}\text{W}_{12}\text{O}_{40}$ , where E is the third metal which can be Pt, Fe, Cu, Cs, Mn, Co, or Pd. Here, hydrogen is being replaced successively with each E metal. *See* Otomo at paragraphs [0033] and [0035]. In fact, the third element could be a group 1A metal or a transition metal, but these metals are replacing the hydrogen atoms successively as shown above but not substituting into the defective vacancy sites.

Additionally, Li does not remedy the deficiency of Otomo because Otomo does not specifically teach or suggest "wherein at least one atom of the noble metal and/or a transition metal is substituted in a skeleton of the heteropolyacid." In contrast to amended claim 1, Li teaches polyanion-based-compounds of the general formula:  $\text{M}_m[\text{X}_x\text{Y}_y\text{O}_z] \cdot n\text{H}_2\text{O}$  where M is selected from the group consisting of group IA and IIA of the Periodic Table; and XY are selected from the group consisting of the elements of Groups IIIB, IVB, VB, and VIB of the Periodic Table. *See* Abstract. Yet, Li does not teach a heteropolyacid including a noble metal

and/or a transition metal and having a molecular weight of 800 to 10000. More importantly, Li fails to teach that at least one atom of the noble metal is substituted in a skeleton of the heteropolyacid as recited in claim 1. Li further teaches that when crystals are grown from a mixture containing different isopolyacids and heteropolyacids in solution, defects in the crystal structure such as dislocation and vacancy can form. *See* Li at col. 2, ll. 12-21. But, Li does not disclose or teach that a noble metal such as platinum (Pt) is substituted into the defective vacancy of the skeleton of the heteropolyacid. The instant specification teaches that the solid polyacid substitutively doped with Pt atoms is made by making a precursor with defective structure through suitable pH adjustment and then inserting Pt atoms or other suitable transition metal atoms into the defective vacancy sites. *See* specification at page 8, lines 1-7 and Example 2, pages 19-23. Accordingly, for at least the above reasons, even if Otomo and Li are combined, their combined teachings does not produce all elements of the invention of amended claim 1 and dependent claims 2-4 and 6-11.

**2. There Is No Motivation in Either Otomo or Li To Combine or Modify the References To Arrive At the Invention of Claims 1-4 and 6-11.**

Moreover, Applicants submit that in this rejection, no objective basis was established for combining the teachings of the Otomo and Li references. Both Otomo and Li never describe a synthesis method of the new heteropolyacid of the present invention, which is obtainable by inserting a noble metal or a transition metal atom such platinum at the atomic level into the “defective vacancy” in the heteropolyacid. For example, Example 2 describes a novel synthetic method of producing the heteropolyacid of this invention, which involves preparing a precursor compound with a “defective vacancy” and then reacting this precursor compound with a compound containing a transition metal. *See*, page 19 line 16 through page 23 line 23. Applicants submit that even if the teachings of Li and Otomo represent a starting point for making a heteropolyacid, novel processes such as selection of the solution, acidity, temperature, and separation method are still necessary to substitute a noble metal and/or a transition metal into the defective vacancy site of a heteropolyacid as illustrated by the Examples in the specification. Applicants further submit that the novel synthetic method produces a new type of heteropolyacid

with an at least atom of a noble metal and/or transition metal substituted in a skeleton of the heteropolyacid.

Although Li teaches that when crystals are grown from a mixture containing different isopolyacids and heteropolyacids, in solution defects in the crystal structure, such as dislocation and vacancy form, Li does not predict a synthetic process of inserting a noble metal into the defective vacancy of the skeleton the heteropolyacid to improve the conductivity. *See* Li at column 2, lines 12-21. Upon reading Li, a person of skill in the art understands that Li predicts that the transition metal in the heteropolyacids can disrupt the crystal lattice to form more defects and that these defects may well result in better ion conduction pathways. *See Id.* In other words, that person of skill in the art would understand that Li is predicting that more defects in the crystal structure of the heteropolyacid leads to better conduction. Accordingly, that person of skill in the art would be motivated to create more “defective vacancies” in the architecture of the heteropolyacid. There is nothing in Li, however, concerning substituting the “defective vacancies” with noble metal atoms and/or transition metals to improve the conduction pathways by a novel synthetic route. Therefore, Li does not provide the requisite motivation to a person of skill in the art to substitute a noble metal and/or a transition metal into the “defective vacancy” site of the skeleton (architecture) of the heteropolyacid because doing so would actually reduce or minimize the “defective vacancies” in the architecture of the heteropolyacid, which is contrary to Li’s teachings.

Similarly, Otomo is silent about inserting a noble metal into a “defective vacancy” of the architecture of a heteropolyacid. As discussed above, the heteropolyacid catalyst of this invention represents a new type of compound, *i.e.*, a hybrid compound with a noble metal and/or a transition metal inserted into the “defective vacancy” of the skeleton (architecture) of the heteropolyacid. Accordingly, absent a reason to specifically substitute a noble metal and or a transition metal into the “defective vacancy” based on the combined teachings of Otomo and Li, the invention of claim 1, as amended, cannot be held obvious.

Based on at least the above arguments, Applicants respectfully submit that neither Otomo alone nor the combination of Otomo and Li teaches or suggests the invention of claims 1-4, 6-11 as amended. Even assuming *arguendo* the teachings are combined, as discussed above, this would not lead to the invention of the amended claims. Accordingly, Applicants respectfully submit that the rejections of claims 1-4 and 6-11 under 35 U.S.C. § 103(a) should be reconsidered and withdrawn.

### **Conclusion**

In view of the foregoing, Applicant respectfully requests reconsideration and the timely allowance of the pending claims. Should the Examiner feel that there are any issues outstanding after consideration of this response, the Examiner is invited to contact Applicant's undersigned representative to expedite prosecution.

Aside from one-month extension of time fees, no other fees are believed to be required for this submission. Should any additional fees be required, however, except for issues payable under 37 C.F.R. 1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. 1.16 and 1.17 which may be required, including any required extension of time fees, or credit any overpayment to Deposit Account 50-0310.

Respectfully submitted,

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